

CLAIMS

What is Claimed is:

1. Method of making films surface imprinted with nanometer-sized particles to
2. produce micro- and/or nano-structured electron and hole collecting interfaces,
3. comprising:
 4. providing at least one transparent substrate;
 5. providing at least one photoabsorbing conjugated polymer;
 6. providing a sufficient amount of nanometer-sized particles to produce a charge
 7. separation interface;
 8. providing at least one transparent polymerizable layer including a sol-gel or
 9. monomer;
 10. embedding said nanometer-sized particles in said conjugated polymer;
 11. applying said polymerizable layer on a first said substrate to form a charge
 12. transport film layer;
 13. applying said conjugated polymer/nanometer-sized particle mixture on a
 14. second said substrate to form a nanometer-sized particles bearing surface film
 15. layer, wherein said nanometer-sized particles form a stamp surface;
 16. imprinting said stamp surface into the surface of said polymerizable film layer to
 17. produce micro- and/or nano-structured electron and hole collecting interfaces;
 18. polymerizing said polymerizable film layer to promote shrinkage to form a
 19. conformal gap between said stamp surface and said surface of said polymerizable
 20. film layer; and

filling said gap with at least one photoabsorbing material to promote the generation of photoexcited electrons and transport to the charge separation interface.

- 1 2. The method according to claim 1, wherein either said applying further comprises at
2 least one of processes of spin-coating, dip-coating, spray-coating, flow-coating,
3 doctor blade coating, and screen-printing.

- 1 3. The method according to claim 1, wherein said imprinting includes compressing and
2 thereafter, solidifying said stamp surface into said surface of said polymerizable
3 layer.

- 1 4. The method according to claim 1, wherein said nanometer-sized particles having
2 average particle sizes of about 1 nm to about 100 nm in diameter and up to about 1
3 nm to about 1 cm in length.

- 1 5. The method according to claim 4, wherein said nanometer-sized particles having
2 average particle sizes of about 1 nm to about 100 nm in diameter and up to about 1
3 nm to about 500 nm in length.

- 1 6. The method according to claim 1, wherein said nanometer-sized particles further
2 comprises at least one of SWNT, and nanocrystals of semiconductor materials.

- 1 7. The method according to claim 6, wherein said nanocrystals of semiconductor
- 2 materials comprises at least one of CdSe, metal nanowires, and metal-filled carbon
- 3 nanotubes.

- 1 8. The method according to claim 1, wherein applying said polymerizable film layer
- 2 ranging in thickness from about 1 nm to about 1 mm.

- 1 9. The method according to claim 1, wherein applying said conjugated polymer
- 2 mixture ranging in thickness from up to about 100 nm.

- 1 10. The method according to claim 1, wherein said polymerizable layer comprises at
- 2 least one monomer.

- 1 11. The method according to claim 1, wherein said polymerizable layer comprises at
- 2 least one sol-gel.

- 1 12. The method according to claim 1, wherein said polymerizable layer includes
- 2 nanometer-sized particles electrophoretically deposited.

- 1 13. The method according to claim 12, wherein said nanometer-sized particles include
- 2 TiO_x nanometer-sized particles.

- 1 14. The method according to claim 11, wherein said sol-gel includes absolute alcohol
- 2 and ultrapure water in a ratio of about (1:0.025) and a metal oxide including titanium
- 3 oxide and/or zinc oxide.

- 1 15. The method according to claim 14, wherein said metal oxide comprises at least one
- 2 of inorganic metal salts and metal organic compounds.

- 1 16. The method according to claim 15, wherein said metal organic compounds include
- 2 metal alkoxides comprising at least one of titanium isopropoxide and zinc butoxide.

- 1 17. The method according to claim 10, wherein said monomer comprising at least one of
- 2 oxadiazole, aniline, and pyrrole.

- 1 18. The method according to claim 1, wherein said substrate(s) includes a silicon
- 2 substrate or silicate substrate.

- 1 19. The method according to claim 1, wherein said substrate(s) includes a transparent
- 2 plastic or plastic-like material.

- 1 20. The method according to claim 1, wherein said substrate acts as an electrode
- 2 comprises a coating of at least one transparent metal oxide including SnO₂:F,
- 3 SnO₂:In (ITO), and Au.

1 21. The method according to claim 1, wherein said substrate acts as an electrode
2 comprises a coating of at least one transparent metal oxide being conducting
3 polymers including polythiophenes, polypyrroles, polyanilines, and
4 polybutylthiophenes.

1 22. The method according to claim 1, wherein said conjugated polymer includes pbT
2 dissolved in chlorobenzene.

1 23. The method according to claim 1, wherein said photoabsorbing material comprises
2 at least one of thermotropic liquid crystalline materials, polybutylthiophene
3 (pbT)/chlorobenzene, and polyelectrolytes.

1 24. The films surface imprinted with nanometer-sized particles produced by the method
2 of claim 1.

1 25. Method of making films surface imprinted with nanometer-sized particles to
2 produce micro- and/or nano-structured electron and hole collecting interfaces,
3 comprising:
4 providing at least one transparent substrate;
5 providing at least one photoabsorbing conjugated polymer including polybutyl-
6 thiophene (pbT);
7 providing a sufficient amount of multiwalled carbon nanotubes (MWNT) to
8 produce a charge separation interface;

9 providing at least one transparent polymerizable layer including a sol-gel or
10 monomer;
11 embedding said MWNT in said conjugated polymer (pbT);
12 applying said polymerizable layer on a first said substrate to form a charge
13 transport film layer;
14 applying said pbT/MWNT mixture on a second said substrate to form a MWNT
15 bearing surface film layer, wherein said MWNT forms a stamp surface;
16 imprinting said MWNT stamp surface into the surface of said polymerizable
17 film layer to produce micro- and/or nano-structured electron and hole collecting
18 interfaces;
19 polymerizing said polymerizable film layer to promote shrinkage to form a
20 conformal gap between said MWNT stamp surface and said surface of said
21 polymerizable film layer; and
22 filling said gap with at least one photoabsorbing material to promote the
23 generation of photoexcited electrons and transport to the charge separation interface.

1 27. The method according to claim 25, wherein said imprinting includes compressing
2 and thereafter, solidifying said MWNT stamp surface into said surface of said
3 polymerizable layer.

1 28. The method according to claim 25, wherein said substrate acts as an electrode
2 comprises an coating of at least one transparent metal oxide including SnO₂:F,
3 SnO₂:In (ITO), and Au.

1 29. The method according to claim 25, wherein said photoabsorbing material comprises
2 at least one of thermotropic liquid crystalline materials, polybutylthiophene
3 (pbT)/chlorobenzene, and polyelectrolytes.

1 30. The method according to claim 25, wherein said films being utilized in a
2 photovoltaic device or other light guiding device.

1 31. Method of making films surface imprinted with nanometer-sized particles to
2 produce micro- and/or nano-structured electron and hole collecting interfaces,
3 comprising:
4 providing at least one transparent substrate;
5 providing at least one photoabsorbing conjugated polymer;
6 providing a sufficient amount of nanometer-sized particles to produce a charge
7 separation interface;
8 providing at least one transparent polymerizable layer including a polymer;
9 embedding said nanometer-sized particles in said conjugated polymer;
10 applying said polymerizable layer on a first said substrate to form a charge
11 transport film layer;
12 applying said conjugated polymer/nanometer-sized particle mixture on a

13 second said substrate to form a nanometer-sized particles bearing surface film
14 layer, wherein said nanometer-sized particles form a stamp surface;
15 imprinting said stamp surface into the surface of said polymerizable film layer to
16 produce micro- and/or nano-structured electron and hole collecting interfaces;
17 polymerizing said polymerizable film layer to promote shrinkage to form a
18 conformal gap between said stamp surface and said surface of said polymerizable
19 film layer; and
20 filling said gap with at least one photoabsorbing material to promote the
21 generation of photoexcited electrons and transport to the charge separation interface.

1 32. The method according to claim 31, wherein said polymer comprising at least one of
2 nitrogen containing heterocycle(s) and polyaniline.